

meant by the velocity of propagation of a wave. In a regular train of waves this was the velocity with which any given phase of a wave moved forward; this could easily be observed in the case of waves on water, but in the case of light no wave form could be observed. The velocity determined by Fizeau's method, or by the eclipses of Jupiter's satellites, was not this, but the velocity of propagation of intermissions of light, which if the true velocity of propagation is a function of the wave-length, is not the same as the true velocity; it is only the same where, as in the case of air, the velocity of propagation is the same for all wave-lengths. Foucault's method (Michelson's) is based on determining the angular motion of a mirror between successive reflections, which again is a different quantity from the former two.

Sir W. Thomson wished to testify that the experiments were made most carefully, and felt unable to suggest any other explanation than Mr. Forbes's, but he felt strong previous objections to accepting it. He pointed out that Mr. Forbes's observations made the velocity of propagation smaller for waves of shorter period, whilst from the analogy of sound in elastic bodies we should expect the opposite.

SECTION B—CHEMICAL SCIENCE

On the Reversals of the Spectral Lines of Metals. By Professors Liveing, M.A., F.R.S., and J. Dewar, M.A., F.R.S.—The authors have a twofold object in view in the study of this subject, (1) to trace the parallel between the condition of the elements as they exist in the sun and those in which they may be placed on the earth; (2), that a knowledge of the reversible lines might aid to distinguish those due directly to the vibrations of the molecules and those produced by superposition of waves or by some strain upon the molecules, such as the electric arc might produce. They classify the reversals, as follows; (1) Reversals produced when the expanded line itself forms the background against which the absorption line is narrowed because the density is less than that of the emitted vapours. These are the ones most generally known. (2) Reversals in which there is little or no expansion of the lines, the background being either the hot walls and end of the tube, the hot pole of the arc, or such part of the spectrum which is so full of lines as to be nearly continuous. Photographs exhibiting the reversals of the lines of iron and other metals, were shown. (3) Reversals in which the background is produced by the expansion of a line of some other metal. Photographs were shown in which the lines of iron and other metals were seen reversed on the expanded lines of magnesium. (4) Reversals produced by the introduction into the crucible in which the arc was of a gentle current of hydrogen, coal gas or ammonia, by which means the metallic lines were almost swept away and the continuous spectrum increased. (5) When a carbon tube passed through a perforation in a block of lime is made the positive electrode of the arc, and a carbon rod passed into another perforation so as to meet the tube in the centre of the block, be made the negative electrode, the tube becomes gradually heated up, and in the direct line of the tube the lines are seen bright, because there is no background, but are seen reversed against the hot walls of the tube. Further the effects of the gradual increasing temperature were traced, as the tube was gradually heated. (6) A double reversal of lines is occasionally observed, and an instance was shown, in which the expansion of the magnesium lines between K and H, had taken place to such an extent as to produce the reversal of the most refrangible of the cyanogen bands; the magnesium producing a broad absorption band against which the magnesium triplet stood out bright and sharp. It is probable that this arises from the less dense but intensely heated magnesium vapour being pushed forward up the tube by the sudden burst of vapour produced when a fresh piece of metal is dropped into the arc.

On the Legal Flashing Test for Petroleum, by F. A. Abel, C.B., F.R.S.—The defects of the old legal flashing test, called the open test, and the test used in the United States, known as the fire-test, led to the introduction of the close-flashing test, which was legalised by Act of Parliament in 1879. The author exhibited the apparatus required, and described the method of using this test. This test has since been adopted in Germany and the United States, and the investigations conducted in the former country by Dr. Foerster and others, showed what had already been observed by the author, that the results obtained with the apparatus were influenced by atmospheric pressure. The most

recent investigations of the author and Mr. B. Redwood, have shown that a variation in the height of the barometer of one inch, was sufficient to produce a change of two degrees Fahrenheit in the flashing point of one and the same sample of oil. Further, it appears that the changes of atmospheric temperature have some influence on the flashing point of a sample of oil, and not only is it necessary to cool down the sample of oil immediately before testing it, when its temperature exceeds 65° F., but it is imperative, in cases where the oil has been stored in localities, the temperature of which is above 65° F., to maintain the oil at a low temperature for a considerable period before testing it. In consequence of this effect of changes of atmospheric temperature, some difficulties have arisen in applying this test in India, and investigations are at present being conducted, the object of which is to ascertain the conditions required for securing the attainment of trustworthy results by the application of this test in tropical climates.

On the Boiling Points and Vapour Tensions of Mercury, of Sulphur, and of some Compounds of Carbon, determined by means of the Hydrogen Thermometer, by Professor J. M. Crafts.—A description was given of the hydrogen thermometer used, the replacement of air by hydrogen was adopted because of the more rapid flow of hydrogen through a capillary tube, further, the bulb of the thermometer could be reduced from 200-500 cc. to 1-10 cc. The thermometer was one of constant volume in which an electric contact between the mercury in the manometer and a platinum point causes a current to excite a magnet and close a cock to arrest the flow of mercury into the manometer tube at the moment the gas attains a fixed volume, as determined by the surface of the mercury touching the platinum point. The boiling point of mercury has been redetermined, and found to be 357° (at the normal pressure), that of sulphur was found to be one degree lower than that assigned to it by Regnault. Naphthalene b. p. 218.08 (bar. 760 mm.), and benzophenone, b. p. 306.1° C. (bar. 760 mm.), were also used to obtain constant temperatures near 200° and 300°. The boiling points of these two substances were determined under reduced pressures varying from 87 to 2,300 mm., giving a series of temperatures that can be easily established and maintained for any length of time, and ranging from 140° to 350°. It is probable that benzene may be easily obtained sufficiently pure to be used in a similar manner. A series of determinations of the boiling points of several carbon compounds have been made, from which it appears that successive, similar additions to the molecular weight do not cause the boiling points to rise by a constant quantity as supposed by Kopp, but that in a large number of cases the increments to the boiling temperatures diminish by a constant quantity.

The Velocity of Explosion of a Mixture of Carbonic Oxide and Oxygen, with varying quantities of Aqueous Vapour, By H. B. Dixon, M.A.—The author has compared the velocities of explosion of mixtures of carbonic oxide and oxygen with varying quantities of aqueous vapour, by observing the pressure registered in a mercurial gauge attached to the endiometer in which the gases were fired. In each experiment the same mass of carbonic oxide and oxygen was exploded at nearly constant volume and temperature. The gauge was U shaped and contained air in the closed limb. An index similar to that used in Six's thermometer was carried up and left at the highest point reached by the mercury. Near the bend of the gauge two bulbs were blown to act as reservoirs, enabling the mercury to be lowered in the endiometer, without allowing air to escape from the closed limb. The endiometer was dried at 80° by drawing through it, for half an hour, air which had passed through tubes containing sulphuric acid, and a tube containing phosphoric pentoxide. It was found that in this way just sufficient aqueous vapour remained in the tube to enable the explosion to take place slowly when the sparks from a Ruhmkorff coil was passed through the mixed gases. In the first experiments several sparks were passed before the gases took fire. Experiments were made in which measured quantities of aqueous vapour were added, and the vapour kept below saturation, and also with the gases saturated with moisture. The results obtained in these experiments show the pressure registered to increase with the amount of moisture present in the gases, and to be the greatest when the gases are saturated.

On the Activity of Oxygen, and the mode of formation of Hydrogen Dioxide, by C. T. Kingzett, F.I.C., F.C.S.—An account is given of the various views held regarding the formation of ozone and hydrogen peroxide by slow oxidation, in the formation of the latter by the slow oxidation of the terpenes, the author considers that an organic peroxide is first formed,

from which by contact with water hydrogen peroxide is produced as a secondary product. The views of Traube (*Chem. Soc. Journ.* 1882, 795) are criticised. The author prefers to represent peroxide of hydrogen as oxygenated water, thus, OOH_2 , rather than hydrogen dioxide, a representation which is considered to explain its properties and reactions more adequately.

Metallic Compounds containing Bivalent Hydrocarbon Radicals, Part III., by Professor I. Sakurai, F.C.S., Tokio University, Japan.—By acting on monomeric methylene iodide $\text{Hg}(\text{CH}_2)_2\text{I}_2$ (described in the Report of 1880) with mercuric chloride, monomeric methylene chloriodide HgCH_2ClI is obtained. This compound is acted upon by iodine, and yields mercuric iodide and methylene chloriodide CH_2ClI , which is a liquid boiling at 109° and having a specific gravity of 2.49 at 20° . The formation of this latter substance shows that monomeric methylene chloriodide has the following constitution, ClCH_2HgI . Attention is drawn to the fact that the boiling point of the methylene chloriodide is approximately the mean of the boiling points of methylene chloride and iodide.

Hydrocarbons of the Formula $(\text{C}_5\text{H}_8)_n$, by Prof. W. A. Tilden, F.R.S.—An account was given of the existing knowledge of isoprene, and the author finds that it forms a tetrabromide $\text{C}_5\text{H}_8\text{Br}_4$, a liquid which cannot be distilled without decomposition. When oxidised by nitric acid isoprene yields oxalic acid, but form and acetic acids are produced when chromic acid is employed. Since isoprene can be converted into caoutchouc, experiments have been made to ascertain whether this hydrocarbon could be obtained from other sources, and inasmuch as isoprene can be converted into a true turpentine, this latter substance was studied with this object. The author found that when turpentine is passed through a red-hot tube a mixture of hydrocarbons is obtained, from which a small quantity of a volatile liquid, having the composition and properties of isoprene, has been isolated. The formulae assignable to the eight possible compounds having the composition of C_5H_8 was discussed, as also was their relation to the terpenes.

The Aerorthometer, an Instrument for Correcting the Measure of a Gas, by A. Vernon Harcourt, M.A., F.R.S.—The object of this instrument is to simplify the method of reducing the volume of a gas to normal conditions of temperature and pressure. The instrument consists of two narrow tubes, the one open above, the other terminating in a bulb, whose capacity, including that of the stem down to the first graduation, is 1000 of the units with which the stem is divided; both tubes are connected below with a reservoir from which mercury can be driven up the tubes by the pressure of a screw. When the mercury stands at the same level in the two tubes, the air in the closed tube, which at 0° and 760 mm. occupies 1000 volumes is under existing atmospheric pressure. It has also the temperature of the surrounding air, and is therefore under the same conditions as the gas in any vessel near it. The volume read on the aerorthometer is to 1000 as the observed volume of the gas in the measuring vessel is to its normal or corrected volume. For the case of measuring gas over water, or in presence of water, the aerorthometer is charged with a drop of water. For technical purposes the graduation "1000" denotes the volume which the inclosed air occupies at 30 inches Bar. and 60° Fahr.

A Revision of the Atomic Weight of Rubidium, by Charles T. Heycock, B.A.—The object of this revision is to ascertain whether the atomic weight of rubidium can be brought into accord with Prout's hypothesis. To this end pure chloride and bromide of rubidium have been prepared, and the amount of chlorine and bromine contained in these, determined by titrating with silver nitrate in a manner identical with that employed by Stas in his classical researches. The results obtained from the chloride give an atomic weight of 85.344 for rubidium, whilst those obtained with the bromide, which the author gives with some reserve, show the atomic weight to be 85.387. These results show that, at present, rubidium cannot be regarded as conforming to Prout's hypothesis.

Method of obtaining Ammonia from Shoddy and Allied Substances, by W. Marriott, F.C.S.—A description of the method of burning shoddy moistened with soda in such a way as to collect the ammonia from the gases produced, and also utilise the combustible gases formed at the same time.

On the Application of the Diamond to Mineralogical and Chemical Analysis, by Prof. von Baumhauer.—The author after describing the various modifications of the diamond, gave an account of some methods in which the diamond might with advantage be employed in mineralogical and chemical analysis for

the purpose of reducing hard substances to a fine state of division.

On the Occurrence of Tellurium and Selenium in Japan, by E. Divers, M.D., Professor, and Masachika Shimoz, Student of Chemistry in the Imperial College of Engineering of Japan.—At the last meeting of the Association a communication was received from Dr. Divers in which it was shown that these elements are found in Japanese sulphuric acid. In this paper a description is given of the sulphur used in the manufacture of the acid, it differs from ordinary sulphur by being reddish-yellow in colour, and is known as *sekiriuseki*, or massive red sulphur, and is obtained from Iwoshima (sulphur island), a specimen of this red sulphur was found to contain 0.17 per cent. of tellurium and 0.06 per cent. of selenium. It is a matter of some interest that tellurium is found associated with sulphur in this state, as it is more usually associated with sulphur in a state of combination with the metals. Analysis of the mud-like deposit found in the vitriol chambers show it to contain some 10 per cent. of selenium and 1.2 per cent. of tellurium, and the sulphuric acid was found to contain 0.37 grams of tellurium and 0.15 gram selenium per liter. Attention is drawn to the fact that whilst the relative proportion between the quantities of tellurium to the selenium is as 5 to 2 in the sulphur, and as 5.5 to 2 in the liquid, it is as 1 to 9 in the deposit. This is easily explained by the fact that finely divided tellurium easily undergoes oxidation in presence of water and air whereas selenium is not so affected. Selenium and tellurium have been obtained by distilling the deposit in clay retorts.

On the Action of the Component Salts as Nuclei on Supersaturated Solutions of certain Double Salts, by John M. Thomson, F.R.S.E., F.C.S.—In a paper published in the *Journal of the Chemical Society*, May, 1879, the author has shown that if a mixture of dimorphous salts be taken, a separation may be effected by touching the solution with a crystal of one or other of the salts; a separation depending on the relative solubilities of the two salts. The investigation has been extended to supersaturated solutions of double salts, and the action upon these of the components of the double salts. Experiments have been made with solutions of double chlorides of mercury and ammonium, of mercuric chloride and ammonium bromide, of mercuric and potassium iodides, and of mercuric ammonium bromides. In these cases it has been found that the salt of the heavy metal is invariably active in producing crystallisation, whereas that of the alkali constituent is inactive. It has also been observed that the true prismatic forms of mercuric chloride and bromide produce crystallisation at once; but that if crystals of other forms are employed, as when obtained by deposition at a higher temperature, then the result is not always so defined. This is no doubt due to the fact that the first form of the heavy metallic salt is more nearly allied to that of the double salt. It appears, therefore, that these double salts of monobasic acids, although forming good supersaturated solutions, are not so firmly united together as to resist the disturbing influence of certain of their constituents, yet the disruption is not sufficient to produce a decomposition, and so a deposit of the double salt is obtained. Experiments with the double salt of mercuric cyanide and ammonium chloride, show that each constituent is active. In the case of the alums, the double phosphates and arseniates neither constituent is active. With Lefort's salts, viz. double sulphates of copper and zinc, both constituents are active, the zinc salt produces the more rapid crystallisation, but the double salt is deposited in each case. In the case of the double tartrates of sodium and potassium it was found that the potassium salt is inactive, whilst the sodium salt is active. An examination of the crystals showed them to have the composition of Rochelle salt; and since the nucleus in no wise resembled this salt in form, it would appear that rochelle salt is probably dimorphous. The activity of sodium tartrate is probably due to its being less soluble than potassium tartrate. In the case of the double citrates of these metals both constituents are active, whilst with the citrates of magnesium and sodium both constituents are inactive. These results show that the union in the double salts of monobasic acids is more of a molecular character, inasmuch as they suffer disruption more easily than do those formed of acids having a higher basicity, such as the alums and phosphates, where there is a firmer union of the constituent salts.

The Decomposition by heat of Potassium Chlorate, by Professor I. M. Crafts and A. Rilliet.—The authors have observed that the addition of metallic silver reduced from the chloride aids

this decomposition, an observation which appears to destroy the usual theories regarding the function of those metallic oxides, which have a similar effect. It was supposed that the action of the catalytic bodies might arise from a power to absorb oxygen, but experiments made by placing black oxide of manganese under conditions similar to those in which it aids the decomposition of potassium chlorate, negated this supposition. Gas retort carbon can be completely burnt by contact with powdered potassium chlorate at 340° , the action is not attended by fusion, and it appears that in this case chemical affinity determines the decomposition. The action of heat upon potassium chlorate was studied by maintaining it at a constant temperature, and it has been observed that the chlorate begins to give off its oxygen between 330° — 340° , *i.e.* at temperatures much below its fusing points. This decomposition goes on for several weeks and finally becomes imperceptibly small, but a rise of temperature or the addition of substances known to favour the decomposition, produce a fresh decomposition leading to a further limit. The authors propose a hypothesis to account for this gradual action of heat upon the chlorate.

SECTION C—GEOLOGY

On the Cause of Elevation and Subsidence of Land, by J. S. Gardner, F.G.S.—The paper claims that the evidence of the permanence of continents is inconclusive as regards eocene and pre-eocene periods, and inquires what the shallower regions of the Atlantic mean, if they do not mean a change of level at the sea-bottom. Assuming with Sir C. Lyell, that at a given depth rocks are molten, and that under further pressure they are reconverted into solids of high specific gravity, the paper demonstrates that the outer envelope is susceptible to and gives way under any increased weight, and recovers when this is removed. The evidence relied upon is that of coral isles, lava-flows, accumulations of ice, and of sediment in deltas, estuaries, and along sea-coasts. In these cases, unless there are counteracting agents, subsidence invariably follows, and littoral seas are thus areas of depression. The increasing pressure in deep oceanic basins acting on the fluid layer leads to the elevation of lines of least resistance into ridges or dry-land, these lines generally coinciding with coast-lines, and to volcanic outbursts. Geology demands pre-eocene communication between many lands. The elevation of land continuous between Europe and America in the north, during the Middle Eocene, was coincident with a cessation in the great formation of basalt, and its subsidence with a renewal of this. The conclusion is drawn that irregularities of surface have and will continue to become more and more accentuated.

Notes relating to the Drift Phenomena of Hampshire: (1) *Boulders, Hayling Island*; (2) *Chert Débris in the Gravel*; (3) *Elephant Bed, Freshwater Gate*, by Prof. J. Prestwich, M.A., F.R.S., refers to the remarkable boulders of crystalline and other old rocks in Pagham, which were noticed long ago by Mr. Dixon, and more recently Mr. Codrington has described similar boulders of Portsea Island, and states that boulders of the same character occur in the gravel of Portsea Island, two boulders of granite, and three of sandstone occurring on the shore near the station, while thirty smaller specimens occurred within a mile westward of the station. Those on the shore facing South Hayling have been collected to form a rockery and local grotto work. The author considers the boulders to have been brought from the Cornwall and Devon coast by floating ice, at the time of the formation of the Brighton raised beach.

On the Sources of the Salt Supply of India, by Prof. V. Ball, F.R.S., states irrigation in some of the central districts in India has produced sterility, by raising the permanent level of the sub-soil water in the ground, which becomes saline by contact with the lower strata, and through capillary attraction, salts of sodium potassium and magnesia were brought to the surface. The author states there are five distinct sources of salt in India, the most important of which are wells which have been sunk to a depth of 100 to 150 feet, and brine obtained, over a large area in the central region of India. In Assam and Burmah saline springs occur in connection with petroleum, 10,000 tons of salt are now being raised from the Sambur Lake. Rock salt occurs of Silurian age, and also in beds of Eocene Tertiary age.

On the Identification of certain Ancient Diamond Mines in India, by Prof. V. Ball, M.A., F.R.S., F.G.S.—The vague references to India as the only then known source of diamonds by the writers of 2000 years ago, give place to more definite indications of position in Sanscrit works of the sixth century,

and possibly of somewhat earlier dates. In the Barhat Sanita a list of localities is given, but as the stones from some of the localities therein mentioned were copper coloured, it is possible that they were not diamonds. In the Ain-i-Akbari (1590), and also less clearly in the Ferishta's History (1425), a locality named Albeniguras is referred to, which can be identified with Wairugurh in the Central Provinces, where the remains of ancient mines are still to be seen. The following localities mentioned by Tavernier (1665), had not been identified until lately, though various attempts had been made by Colonel Rennell and others since his time. Gani or Coulour is Kollur on the Kistna; Raolconda is Ramulkota in Karnul; Soumelpour was on the Koel river in the Palamow district of Bengal. Kollur would appear from Tavernier's statement to have been the mine where the Great Mogul diamond was found. The same stone is mentioned by Garcias ab Horto, who wrote 100 years before Tavernier. Prof. Ball is of opinion that this stone, which was probably found in the middle of the sixteenth century, was the original of the Koh-i-nur. The author referred to several other early authorities, and to the mythical stories which are connected with the accounts of diamond mining, for the origin of which he proposed explanations.

On the Geology of Cardigan Town, by G. W. Keeping, M.A.—The author considers the Geological Survey in error as to the horizon, on which they place the Silurian rocks, underlying this town.

Notes on the Bure Valley Beds and Westleton Beds, by H. B. Woodward, F.G.S., considers the introduction of the term "Chillesford clay," and its supposed identification with any laminated clay that occurs on any horizon in the Norwich Crag, to have been the source of the confusion at present existing. The author finds there is no division between the Bure Valley beds and the Norwich Crag below, and that Messrs. Wood and Harmer are incorrect in referring that the former deposits are Lower Glacial.

The Iron and Lead Measures of Tynehead, Alston, by Mr. C. E. De Rance, F.G.S., of H.M.'s Geological Survey.—The Carboniferous Limestone of this area is split up into a series of limestone separated by thick beds of shale and sandstone, and traversed by an intrusive sheet of basalt, known as the Whin Sill; the section above that horizon consists only of about 200 feet of limestones, while sandstones reach 350 feet, and shales 520 feet. Beneath the Whin Sill there are 900 feet of measures, in which occur many important beds of limestone, one of which, the Melmerby Scar Limestone, reaches a thickness of 124 feet. The chief lead measures occur in the Great Limestone (70 feet), the Scar Limestone (30 feet), and the Tyne-bottom Limestone. The latter, deriving its name from its gradual inclination northward, forming the floor of the River Tyne; below this horizon but little has been done in proving the lead lodes in depth, owing to the water-charged condition of the rocks beneath. The veins in nearly every case are faults of small throw, when these traverse limestones, the veins contain lead; when they pass through sandstones they contain copper, and in both cases the sides consist of valuable deposits of brown hæmatite, which occasionally reach a thickness of 6 or 7 feet. These at present are not worked, but should a railway be carried up the Tees and into the South Tyne Valley, as is proposed to connect Alston with Middleton in Teesdale, these valuable deposits will be available for use in the Middlesboro district.

Notes on Alpine Post-Carboniferous (Dyassic) and Triassic Rocks, by the Rev. A. Irving.—This paper is merely supplementary to what has recently appeared in the *Geological Magazine*, on the Dyas and Trias of Europe. Attention is especially drawn to the three following points in connection with the Alpine Dyas ("Permian"):(1) the occurrence of the *Verrucano*, its possible equivalence with the Rothliegende, as advocated by Gümbel, in opposition to the view of von Hauer, who prefers to regard it as belonging to the lowest horizon of the Trias; (2) the great volcanic activity manifested in the Alpine area in post-Carboniferous times, as illustrated by the great porphyry district of Bozen (in connection with which the structure of the Rittler Horn, a "stratified cone," with interbedded "ash" beds and porphyries, is described from recent observations by the author); (3) the occurrence of certain Alpine deposits (especially the Bellerophon Limestone of the Puster Thal, and the Grödner Sandstein at Neumarkt near Bozen), which, on palæontological grounds, are regarded by Gümbel as representing a "transition series from the Dyas to the Trias." Attention is also drawn to the correlation of the Triassic deposits on the northern and southern sides of the great